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Title: A new approach to measure the light absorption of aerosols

Author(s): Gorkowski, Kyle Joseph
Jordan, Spencer Halloran
Benedict, Katherine Beem

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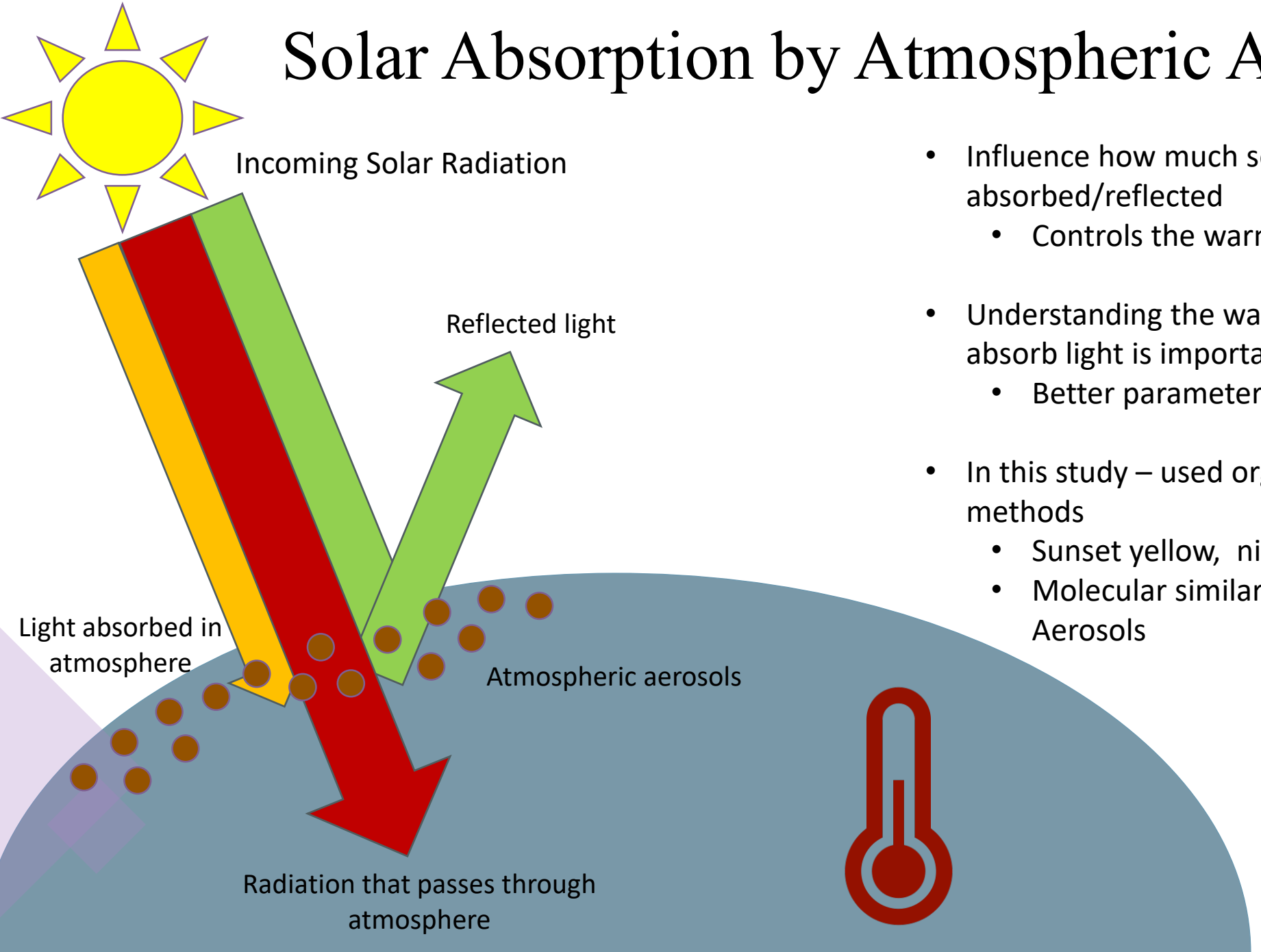
A new approach to measure the light absorption of aerosols

Spencer Jordan

Mentored by: Kyle Gorkowski and Katie Benedict

Solar Absorption by Atmospheric Aerosols



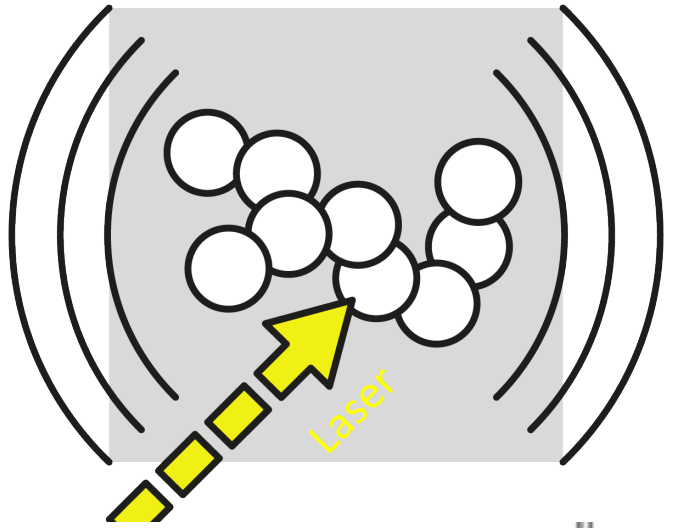
- Influence how much solar radiation gets absorbed/reflected
  - Controls the warming and cooling of the planet
- Understanding the wavelengths at which aerosols absorb light is important to climate models
  - Better parameterization
- In this study – used organic dyes to validate the methods
  - Sunset yellow, nigrosin, fluorescein-sodium-salt
  - Molecular similarities to common Organic Aerosols

Current Methods of Aerosol Absorption Measurement

- Aerosol instruments typically measure absorption and scattering of light
  - Inversion algorithms are used to retrieve the refractive index
    - This process has a high uncertainty

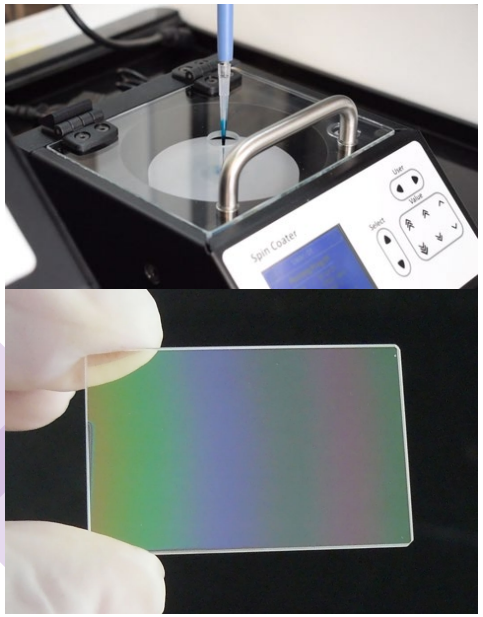
- Photoacoustic methods
  - Measure the absorption of single particles with laser beam
  - Single wavelength instruments

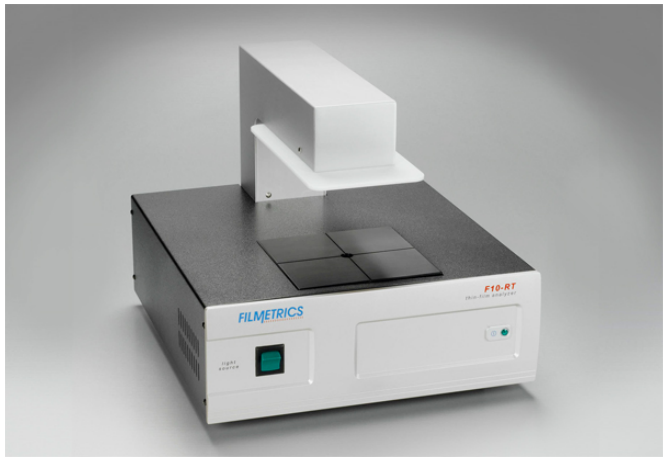
- Filter based methods
  - Collects samples on filter then measures attenuation
  - Biases exist due to light scattering off the filter paper
    - Can get overloaded with aerosol

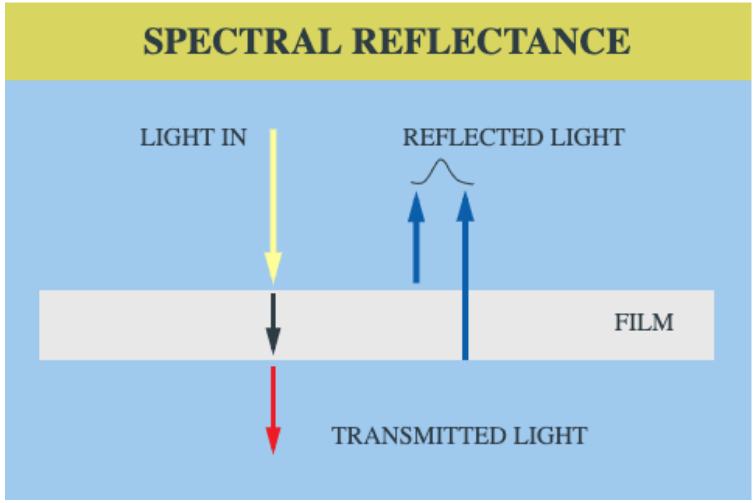


Bringing Thin-film Techniques to Aerosol Measurement

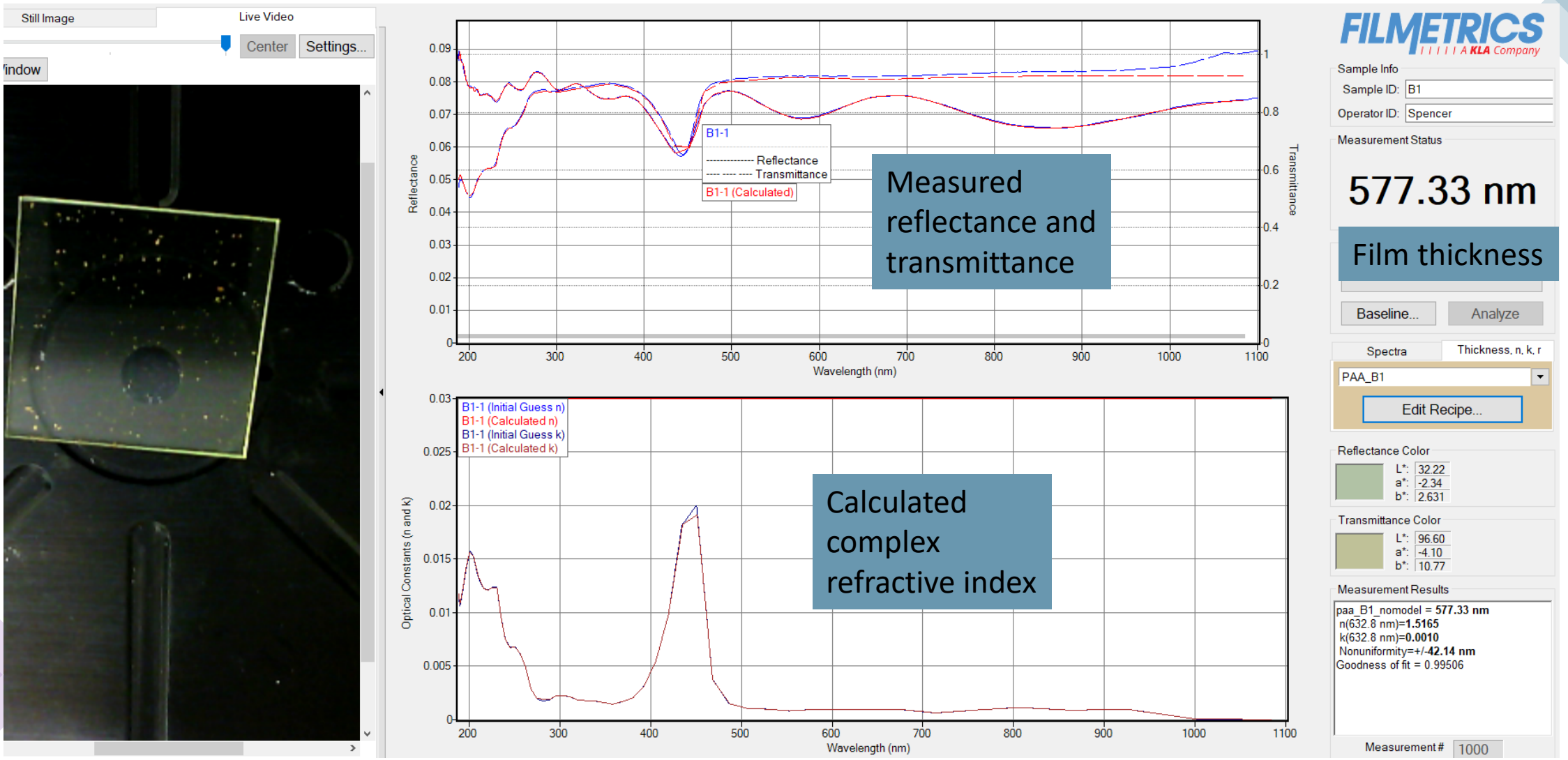
- We used a spin coater to create thin, uniform layers of solutions onto glass slides
- Slides could then be scanned with a spectrometer to measure reflection and transmission of light
- Spectrum is used to calculate both the thickness and refractive index







Spectrometer Analysis

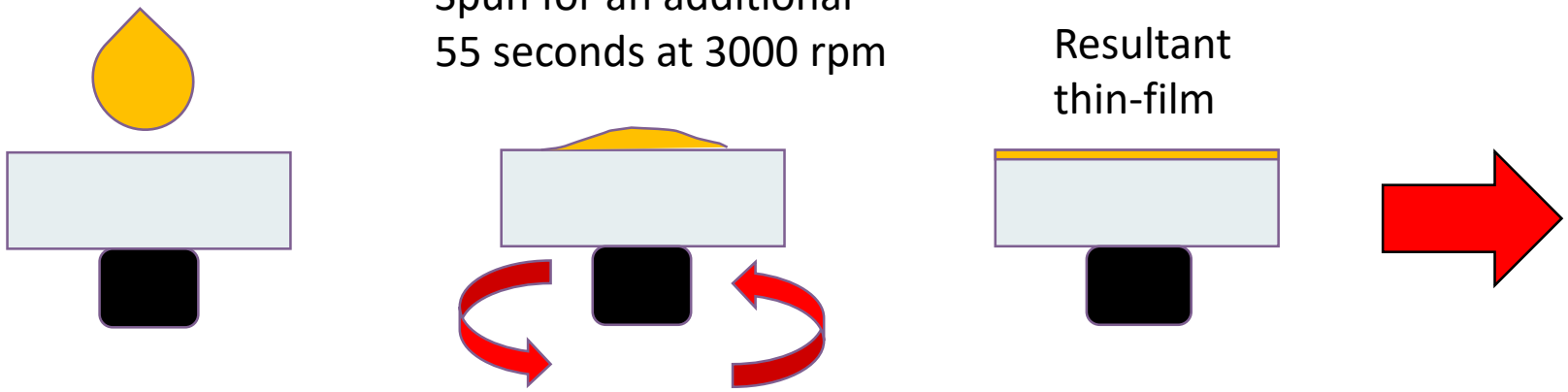


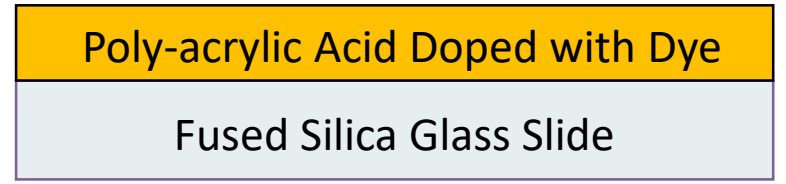
Direct Chemical Doping Method

Injection of solution onto slide - while spinning at 3000 rpm

Spun for an additional 55 seconds at 3000 rpm

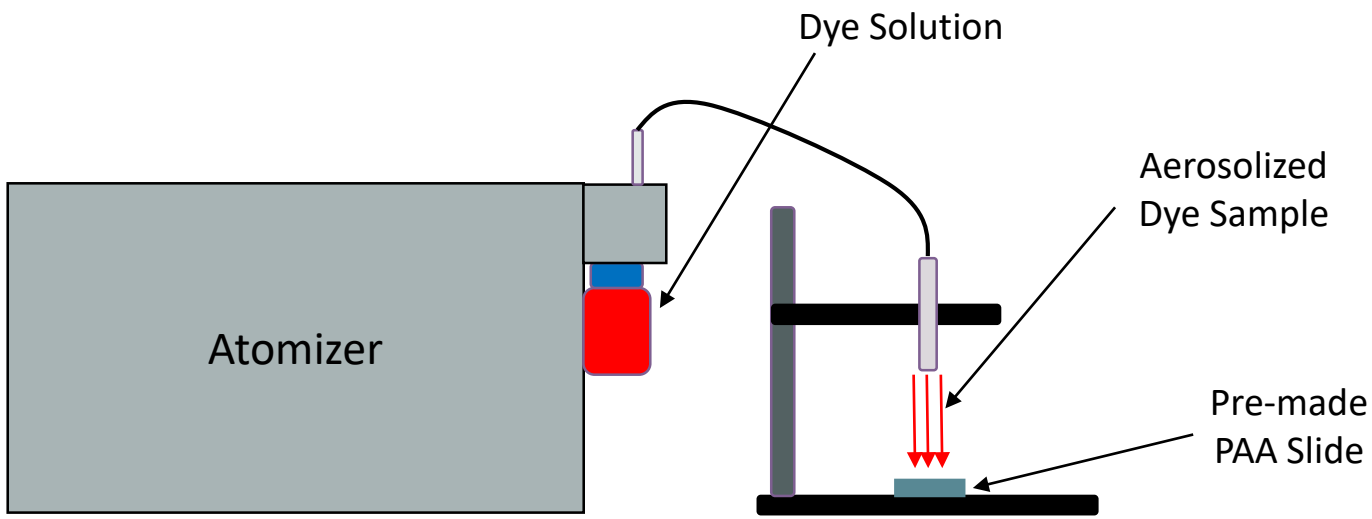
Resultant thin-film

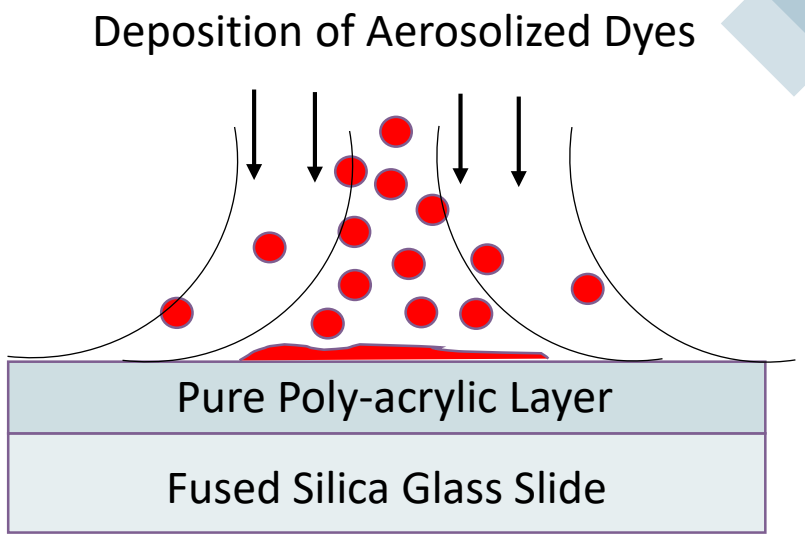




- Poly-acrylic acid (PAA) and water solutions doped with several concentrations of sample dyes
- Very low non-uniformity (< 10 nm), consistent thicknesses

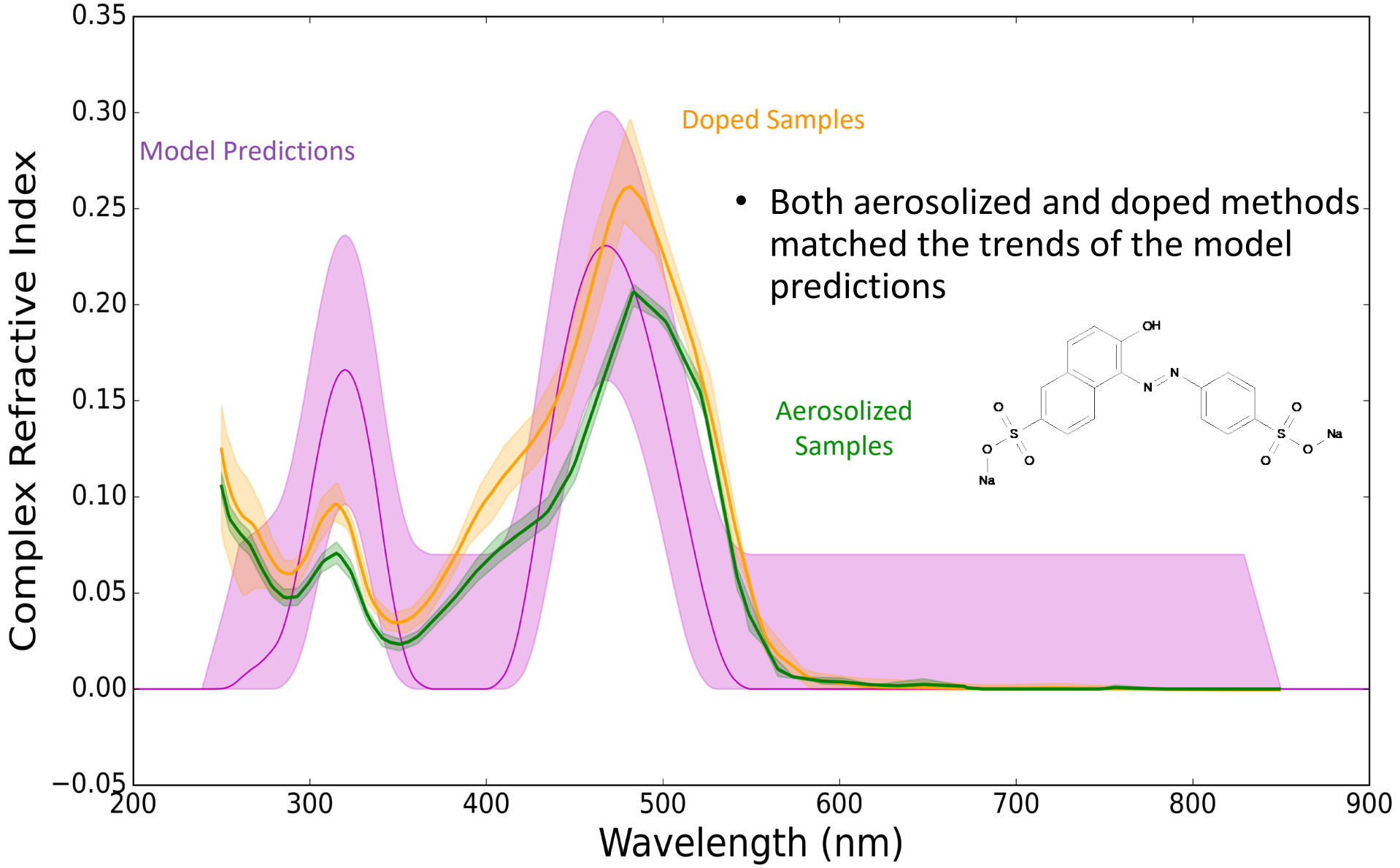
Deposition of Aerosolized Dyes





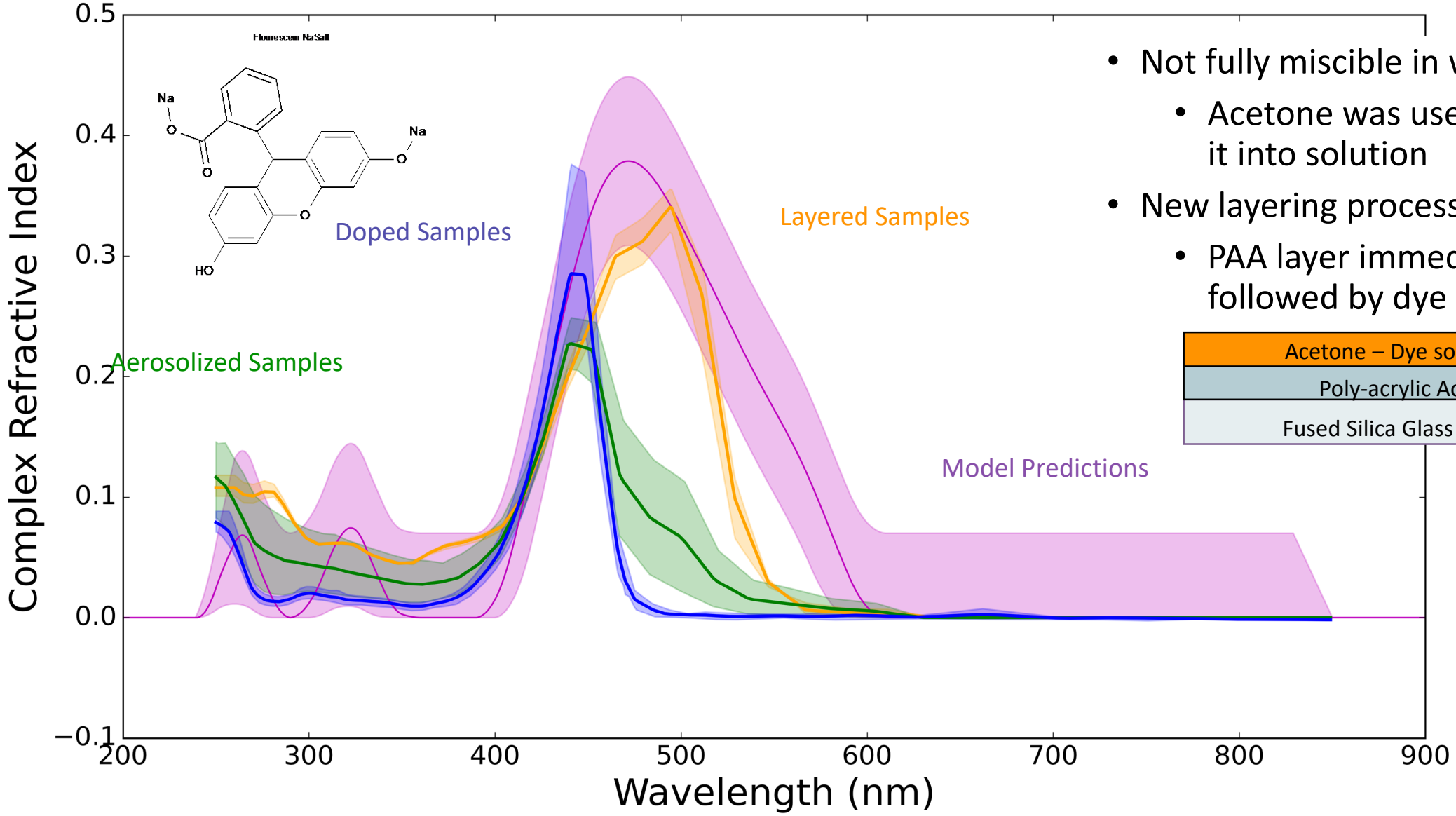
- Aerosols were collected in small areas on the surface of the slides
  - ‘Layers’ were less uniform than the doping method
- Future work will look at improved impaction methods

Sunset Yellow: All Collection Methods Compare Well



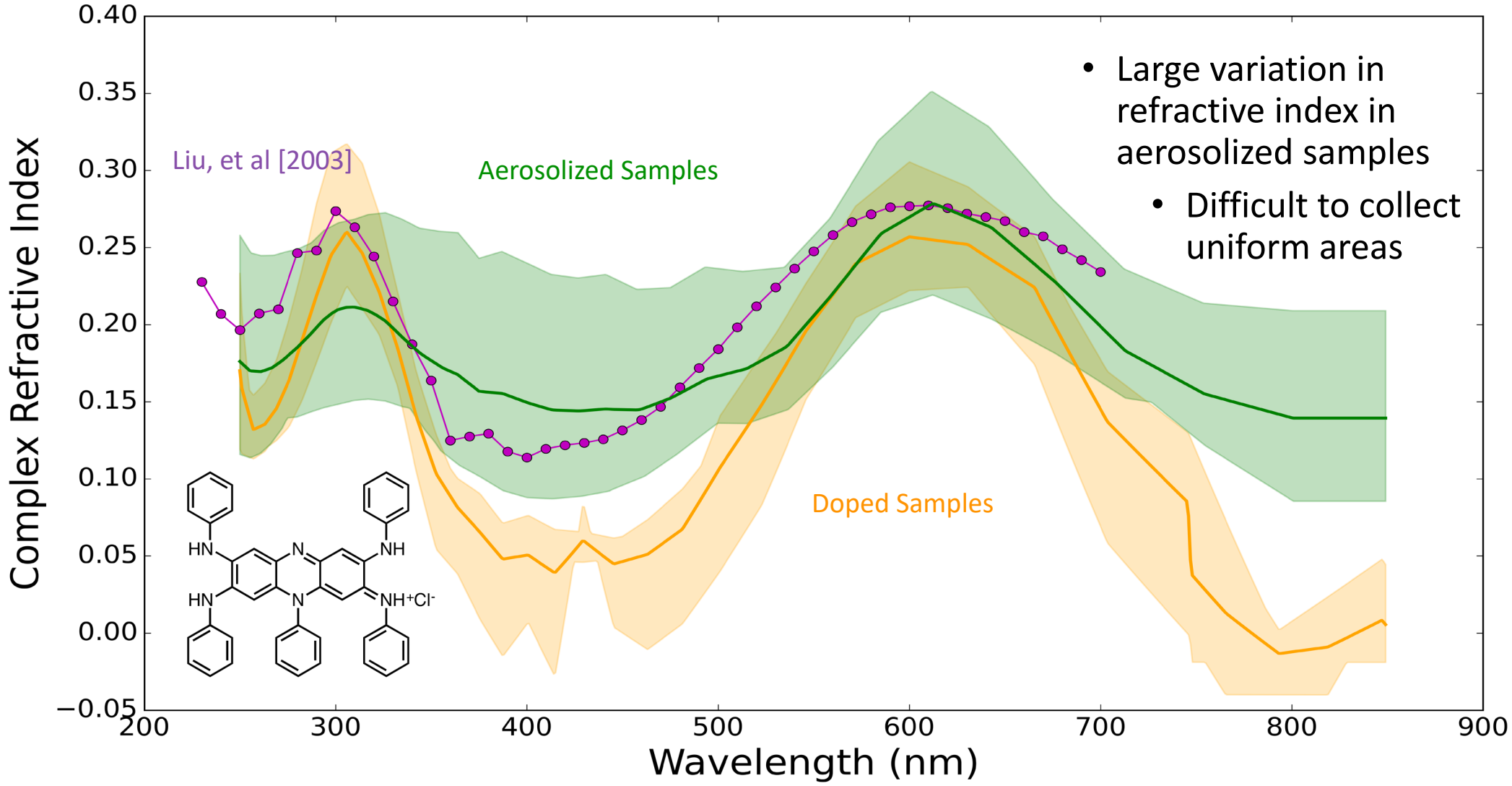
- Both aerosolized and doped methods matched the trends of the model predictions

Challenges of Fluorescein Sodium Salt



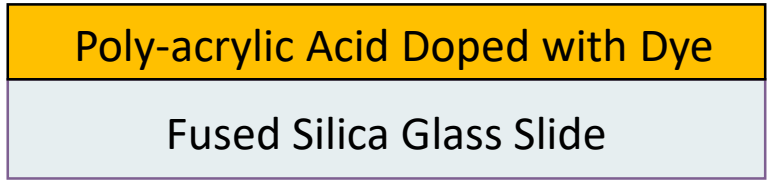
- Not fully miscible in water
  - Acetone was used to bring it into solution
- New layering process was used
  - PAA layer immediately followed by dye solution

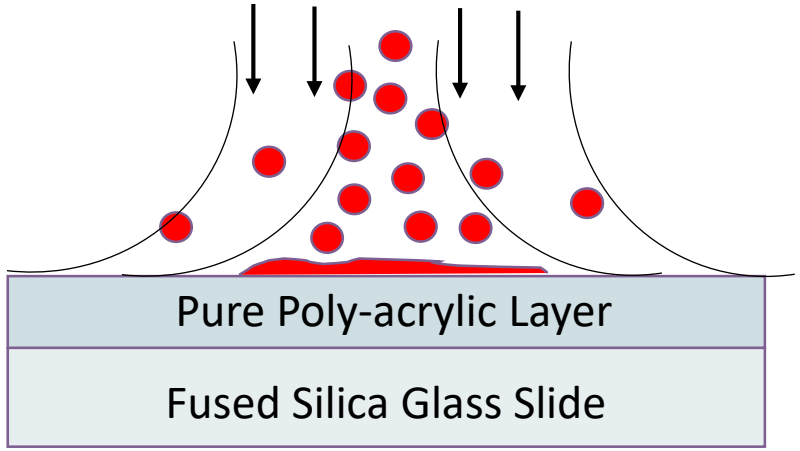
Aerosolized Nigrosin Samples Agree well with Literature



- Large variation in refractive index in aerosolized samples
  - Difficult to collect uniform areas

Doped and Aerosolized Slides Generally Agreed





- Future Works
  - Develop aerosol collection process
    - 3D printed slide holders
    - Aerosol Impaction Simulations
  - Deploy in the field
    - Urban pollution
    - Wildfire observations

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